CLAIMS

We claim:

1. In an operator-sensing circuit having a charge-transfer sensor that sends a sensor charge signal to a capacitive sensing electrode and receives a discharge signal from the electrode for disabling the motor of a unit of power equipment upon the absence of an operator's hand on a hand-gripping surface of the equipment, the electrical characteristic comprising:

a) capacitive means for operating within a predetermined output capacitor discharge range that includes preselected binary digit values that designate hands-off and hands-on conditions on the hand-gripping surface;

b) said capacitor discharge range is effective to distinguish between the presence of an operator's hand and foreign material on the gripping surface for avoiding a false hands-on signal.

2. The characteristic as defined in claim 1, wherein

said capacitive means includes operator-hand sensing electrode means having an inner dielectric material layer contiguously disposed on a metal handle portion of the power equipment, a metal conductor material layer contiguously disposed on the dielectric material, and an outer dielectric hand-grip material including said hand-gripping surface thereby producing a capacitance in a grasping operator's hand, outer hand-grip material, and the metal conductor material layer;

said conductor layer includes metal foil wrapped around said inner dielectric material.

3. The characteristic as defined in claim 2, wherein

said metal conductor material comprises copper and the foil layer has a thickness of about 0.10 mm to about 0.15 mm.

4. The characteristic as defined in claim 2, wherein

said inner dielectric material layer has the structural configuration of a tube that extends

along the length of the metal handle portion;

said metal foil has the structural configuration of a tube having a longitudinal axis and that extends along a delimited length of the inner dielectric material tube, and has opposed end edges that are each disposed in respective planes that traverse the longitudinal axis of the metal foil tube; and

said outer hand-grip material has a length sufficient to overlap the opposed end edges of the metal foil tube.

5. The characteristic as defined in claim 3, wherein

said metal foil tube has a length of from about 50 mm to about 60 mm, the opposed end edges are disposed about 30 mm from the ends of the hand-grip material, and the opposed respective transverse planes are perpendicular to the longitudinal axis of the foil tube.

6. The characteristic as defined in claim 1, wherein

said capacitor discharge range includes a hands-off section in which foreign materials add capacitance to the hand-gripping surface that may produce a false hands-on condition, and a true hands-on section in which the operator's hand is grasping the hand-gripping surface provides an accurate capacitor discharge digit value that allows the power equipment continued operation.

7. In an operator-sensing circuit having a charge-transfer sensor that sends a sensor charge signal to a capacitive sensing electrode and in response receives a discharge signal from the electrode for disabling the motor of a unit of power equipment upon the absence of an operator's hand on a hand-gripping surface of the equipment, the combination comprising:

a) multiplexing means and capacitive means including operator-hand sensing electrode means and reference simulator electrode means for receiving said sensor charge signal from the multiplexing means;

b) said simulator electrode means being effective to send a reference discharge signal

having a designated standard digit value for determining a defect in the operator-sensing system;

c) microcontroller means electrically coupled to said multiplexing means including a series of switches for issuing electrode switching signals to alternately turn said series of switches on and off to sequentially send said sensor charge signal to each sensing electrode means and reference simulator electrode means, and in response to sequentially receive from each sensing and reference electrode means respective electrode discharge digit signals;

d) said microcontroller means electrically coupled for issuing command signals to said charge-transfer sensor to send said charge signal to the multiplexing means for distribution to said sensing and reference electrode means;

e) said charge-transfer sensor being effective to send a raw data output discharge signal corresponding to each said respective electrode discharge digit signal to said microcontroller means for processing; and

f) said microcontroller means being effective to disable said engine upon determining that the reference discharge signal does not conform to said designated standard digit value, and upon alternatively determining that the electrode sensing discharge signal indicates the absence of the operator's hand from the hand-gripping surface.

8. The combination as defined in claim 7, wherein

said circuit includes capacitive means and said microcontroller means is programmable for setting a predetermined operating output capacitor discharge range including preselected binary digit values that designate hands-off and hands-on conditions on the hand-gripping surface;

said capacitor discharge range is effective to distinguish between the presence of an operator's hand and foreign material on the gripping surface for avoiding a false hands-on signal.

9. The combination as defined in claim 8, wherein

a preselected binary digit value of about 700 digits designates a hands-on condition for the

sensing electrode means affixed to a hand-gripping surface, and a preselected binary digit value of about 900 digits designates a hands-off condition for the sensing electrode means affixed to a hand-gripping surface.

10. The combination as defined in claim 8, wherein

said capacitor discharge digit value of said reference simulator electrode means is about 400 digits.

11. The combination as defined in claim 8, wherein

said capacitor discharge range includes a hands-off section in which foreign materials add capacitance to the hand-gripping surface that might produce a false hands-on condition, and a true hands-on section in which the operator's hand is grasping the hand-gripping surface to provide an accurate capacitor discharge digit value that allows the power equipment continued operation.

12. The combination as defined in claim 11, wherein

said capacitor discharge digit value range of said true hands-on section is about 700 to about 750 digits, and

said capacitor discharge digit value range of said false hands-on section is about 750 to about 900 digits.

13. The combination as defined in claim 7, wherein

the microcontroller means includes a first microprocessor means electrically coupled to the charge-transfer sensor and second microprocessor means electrically coupled to the first microprocessor means;

said first microprocessor means electrically coupled to the multiplexing means for sequentially turning sensing electrode and reference simulator electrode switches on and off to send said charge signals through to the respective sensing and reference electrode means;

said first microprocessor means being effective for commanding the sensor to send charge signals to the multiplexing switches to be sent through to the sensing and reference electrode means that in response send capacitive discharge signals to the sensor means which produces respective raw data output signals corresponding to the capacitive discharge signals received;

said second microprocessor means being effective to receive the raw data output signals to conduct a control check on the first microprocessor means and to double check the raw data output signals;

said first and second microprocessor means being electrically coupled to respective relay switches that are, in turn, electrically coupled to the ignition system of the motor;

each said first and second microprocessor means independently processes said raw data output signals to produce an output microprocessor signal to its respective relay switch that is effective to shut the ignition down when said microprocessor output signals to their respective relay switches are not the same.

14. A method of sensing the presence of an operator's hand on a gripping surface of a power equipment unit and causing cessation of operation of a component system of the equipment if the operator's hand is removed from the gripping surface, the steps of the method comprising:

a) providing a sensing electrode affixed to said gripping surface that includes a capacitive means for operating within a predetermined output capacitor discharge range including preselected binary digit values that designate hands-off and hands-on conditions on the hand-gripping surface;

b) said capacitor discharge range is effective to distinguish between the presence of an operator's hand and foreign material on said gripping surface for avoiding a false hands-on signal;

c) said capacitor discharge range includes a hands-off section in which foreign materials add capacitance to the hand-gripping surface that may produce a false hands-on condition, and a true hands-on section in which the operator's hand is grasping the hand-gripping surface and provides an

accurate capacitor discharge digit value that allows the power equipment continued operation;

d) providing a charge-transfer sensor electrically coupled to the sensing electrode;

e) providing microcontroller means electrically coupled to the charge-transfer sensor for periodically commanding the sensor to transfer charge to the sensing electrode that senses the quantity of charge on the sensing electrode and generates a raw data output signal to the microcontroller means when the quantity of charge on the sensing electrode is sensed;

f) processing the raw data output signal in said microcontroller means to determine if the quantity of charge on the sensing electrode is in said true hands-on section of the capacitor range;

g) said microcontroller means is electrically coupled to said component system of the equipment and causes cessation of operation of the component system when the raw data output signal of the charge-transfer sensor indicates that the quantity of charge is not within the true hands-on section of said capacitor discharge range.

15. The method as defined in claim 14, wherein

the component system is an internal combustion engine of the equipment and electrically couples the ignition system of the engine to ground to shut off the engine when the raw data output signal indicates that the quantity of charge is not within the true hands-on section of said capacitor discharge range.

16. The method as defined in claim 14, wherein

the component system is an electric motor of the equipment and electrically interrupts a supply of power to the electric motor to shut off the electric motor when the raw data output signal indicates that the quantity of charge is not within the true hands-on section of said capacitor discharge range.

17. A capacitive operator-sensing circuit in combination with a mobile power equipment unit, the

combination comprising:

a) the mobile power equipment including an internal combustion engine, a magneto of the engine's ignition system, and a hand-gripping surface for an operator to grip and control movement of the mobile power equipment unit;

b) the capacitive operator-sensing circuit being adapted to sense the presence of an operator's hand on the gripping surface to shut off the engine if the operator's hand is absent from the gripping surface,

c) the capacitive operator-sensing circuit including sensing electrode means affixed to said gripping surface that includes capacitive means for operating within a predetermined output capacitor discharge range that includes preselected binary standard digit values that designate hands-off and hands-on conditions on the hand-gripping surface;

d) said capacitor discharge range including a hands-off section in which foreign materials add capacitance to the hand-gripping surface that may produce a false hands-on condition, and a true hands-on section which indicates that the operator's hand is grasping the hand-gripping surface;

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e) said sensing electrode means is electrically coupled to charge-transfer sensor means for sensing any quantity of charge on the electrode means;

f) said charge-transfer sensor means is electrically coupled to the microcontroller means for periodically commanding the sensor means to transfer charge to the sensing electrode means, and to sense the quantity of charge on the sensing electrode means;

g) said sensor means being effective to generate raw data output signals for the microcontroller means to process when the quantity of charge on the sensing electrode is sensed;

h) said microcontroller means being effective to process a raw data output signal for determining if a corresponding quantity of charge on the sensing electrode is in said true hands-on section of the capacitor range;

i) said microcontroller means being electrically coupled to said magneto of the ignition system for causing cessation of the engine when the raw data output signal of the charge-transfer sensor means indicates that the sensed quantity of charge is not within the true hands-on section of said capacitor discharge range.